1. (10 points) The velocity of a particle is given by the equation $v(t) = 3t^2 - 6t + 1$ *ft/s*, where t is in seconds. Determine the position and acceleration of the particle when t is equal to 2 seconds.

$v = 3t^2 - 6t + 1$

$\frac{ds}{dt} = 3t^2 - 6t + 1$

$s = t^3 - 3t^2 + t$

$s = (2)^3 - 3(2)^2 + (2)$

$s = \boxed{22.0\ ft}$

$v = 3t^2 - 6t + 1$

$\frac{dv}{dt} = 6t - 6$

$a = 6t - 6$

$a = 6(2) - 6$

$a = \boxed{6.00\ ft/s^2}$

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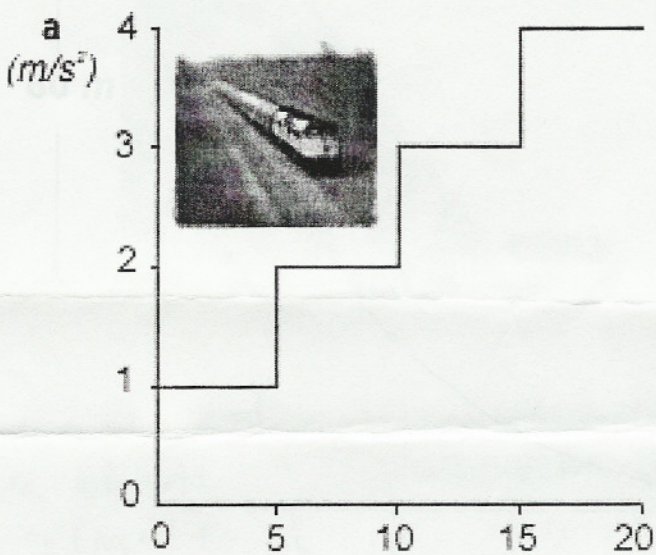
2. (30 points) You are a summer student at *VIA Rail*, where the engineers have proposed an incremental acceleration scheme, shown below in the a–t plot. On your first day you are assigned the following duties:

a) construct the v-t plot showing the velocity at 5,10,15, and 20 seconds,

b) construct the s-t plot showing the position at 5,10,15, and 20 seconds,

c) convert the final velocity and position into *km/h* and *km* respectively, for the *VIA* marketing staff.



Given

$a(0 \le t \le 5) = 1\ m/s^2$

$a(5 \le t \le 10) = 2\ m/s^2$

$a(10 \le t \le 15) = 3\ m/s^2$

$a(15 \le t \le 20) = 4\ m/s^2$

Find → A) v-t plot

B) s-t plot

C) Final velocity in km/h and position in km.

Solution

A) $0 \le t \le 5$

$a = 1$

$v = t + C$

$v = t$

$5 \le t \le 10$

$a = 2$

$v = 2t + C$

$v = 2t - 5$

$10 \le t \le 15$

$a = 3$

$v = 3t + C$

$v = 3t - 15$

$15 \le t \le 20$

$a = 4$

$v = 4t + C$

$v = 4t - 30$

30

$v(t) = t$

$v(5) = \boxed{5.00\ m/s}$

$v(t) = 2t - 5$

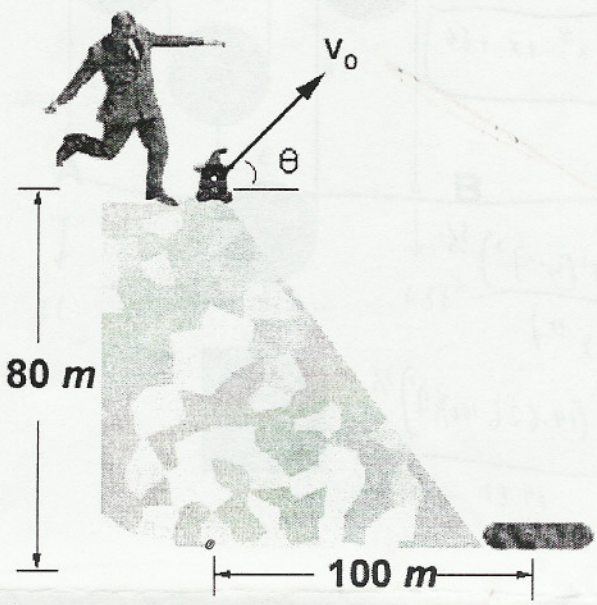
$v(10) = \boxed{15.0\ m/s}$

3. (30 points) Given the hypothetical situation shown in the figure below, determine the following:

a) What speed ($|v_o|$) is required to project the Furby to the safety mat?
b) What is the equation of the Furby's path ($y = f(x)$)?
c) What are the normal and tangential components of acceleration just prior to the furby's landing?

Assume that the launch angle (θ) is 45° relative to the horizon, and that the furby can be accurately modeled as projectile.

Editors Note: Furbies are not animals; rather, they are toys that talk. The College of Engineering does not condone violence towards animals.



Given

$x_0 = 0$ m $x = 100$ m

$y_0 = 80$ m $y = 0$ m

Find → A) V_0

B) equation

C) a_t and a_n

tion

$x = x_0 + v_0 t + \frac{1}{2} a t^2$

$x = x_0 + V_0(\cos\theta)t$

$100 = V_0(\cos 45)t$

$100 = 0.707\, V_0 t$

$t = \frac{100}{0.707\, V_0}$

$t = \frac{141.4}{V_0}$

$y = y_0 + V_0 t + \frac{1}{2} a t^2$

$0 = 80 + V_0(\sin\theta)t + \frac{1}{2} a t^2$

$0 = 80 + (\sin 45^\circ)(141.4) + \frac{1}{2} a \left[\frac{141.4^2}{V_0^2}\right]$

$0 = 80 + 100 + \frac{98070}{V_0^2}$

$-180 = \frac{98070}{V_0^2}$

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$V_0^2 + a(s - s_0)$

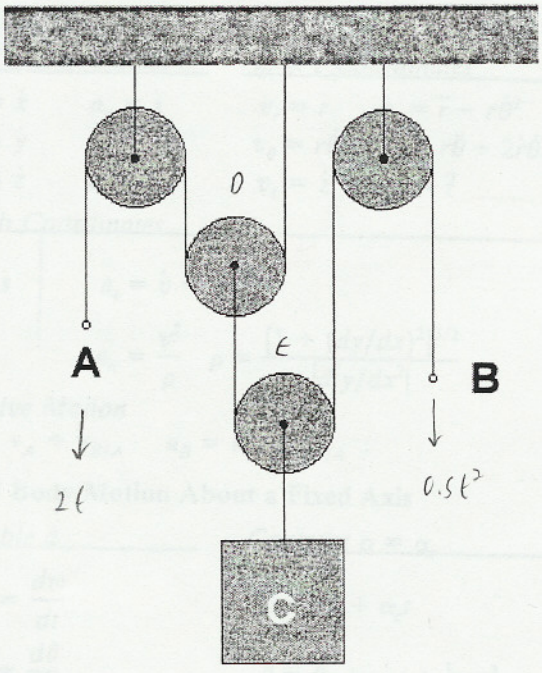
$V_0^2(\sin^2\theta) + 9.81(0 - 80)$

4. (30 points) For the pulley arrangement shown in the figure below, the velocity of points A and B are $2t(ft/s)$ and $0.5t^2$ (ft/s) in the downward direction, respectively. Determine:

a) the velocity of block C as a function of time,

b) the relative velocity of C with respect to A as a function of time,

c) the relative acceleration of C with respect to A when t = 1 s.



Given

$v_A = 2t$

$v_B = 0.5t^2$

Find → A) v_C

B) v_{CA}

C) a_{CA}

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A) $l = s_A + 2s_D$

$0 = v_A + 2v_D$

$v_D = -\frac{1}{2} v_A$

$v_D = -\frac{1}{2}(2t)$

$v_D = -t$

$l = s_B + 2s_E + s_D$

$0 = v_B + 2v_E + v_D$

$v_E = \frac{1}{2}(-v_B - v_D)$

$v_E = \frac{1}{2}(-0.5t^2 - t)$

$v_E = -\frac{1}{4}t^2 - \frac{1}{2}t$

$v_C = v_E$

$\boxed{v_C = -\frac{1}{4}t^2 - t}$

direction?

carried thru.

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B) $v_{CA} = v_C - v_A$

$v_{CA} = (-\frac{1}{4}t^2 - t) - (2t)$

$\boxed{v_{CA} = -\frac{1}{4}t^2 - 3t}$

C) $v_A = 2t$

$a_A = 2$

$v_C = -\frac{1}{4}t^2 - t$

$a_C = -\frac{1}{2}t - 1$